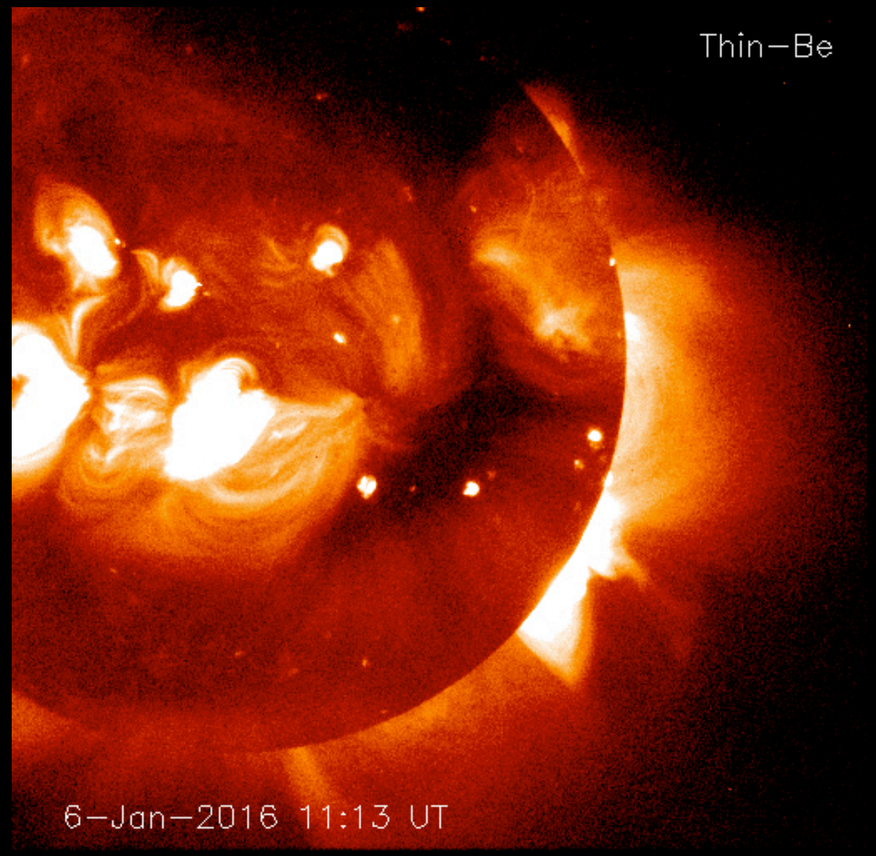
Supra Arcade Downflows in the Earth's Magnetotail

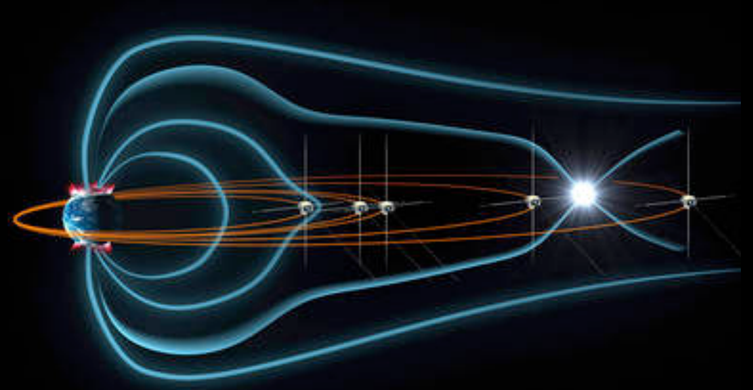


Adam R. Kobelski (UAH)
Sabrina L. Savage (MSFC)
David M. Malaspina (LASP)

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

NASA

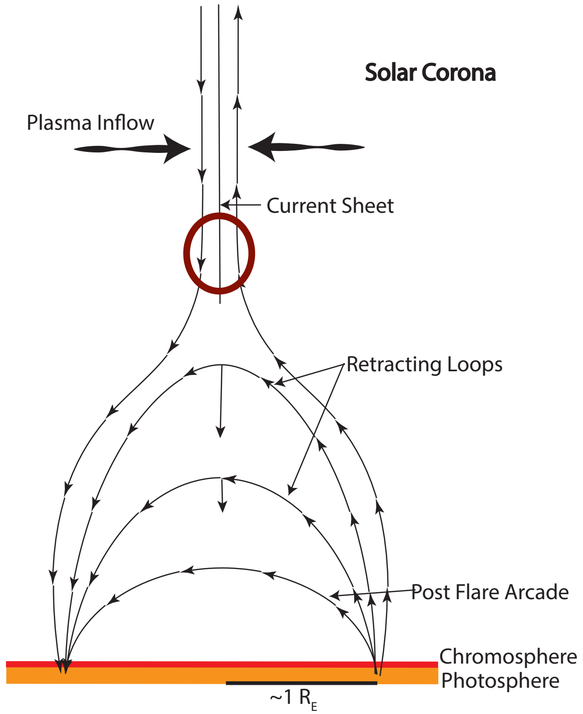
LASP



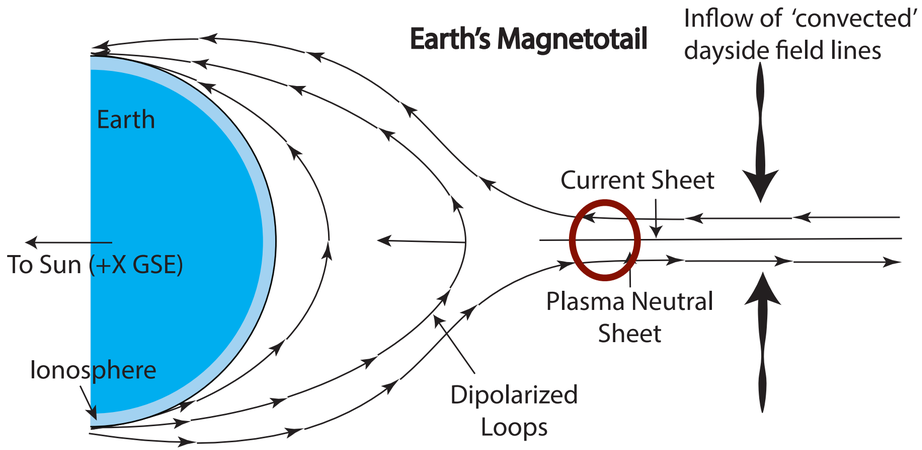
Overview

- Comparison of Coronal and Magnetotail Reconnection
- Supra Arcade Downflows (SADs)
- Magnetotail Reconnection and Observations
- Dipolarization Fronts (DPFs)
- DPFs and SADs

Reconnection in the Corona vs The Magnetotail



$$n \approx 3 \times 10^9\,\mathrm{cm}^{-3}$$
$$T \approx 13 \times 10^6\,\mathrm{K}$$
$$B \approx 6\text{–}16 \times 10^5\,\mathrm{nT} = 6\text{–}16\,\mathrm{G}$$



$$n \approx 1\,\mathrm{cm}^{-3}$$
$$T \approx 12 \times 10^6\,\mathrm{K}$$
$$B \approx 10\,\mathrm{nT} = 10^{-4}\,\mathrm{G}$$

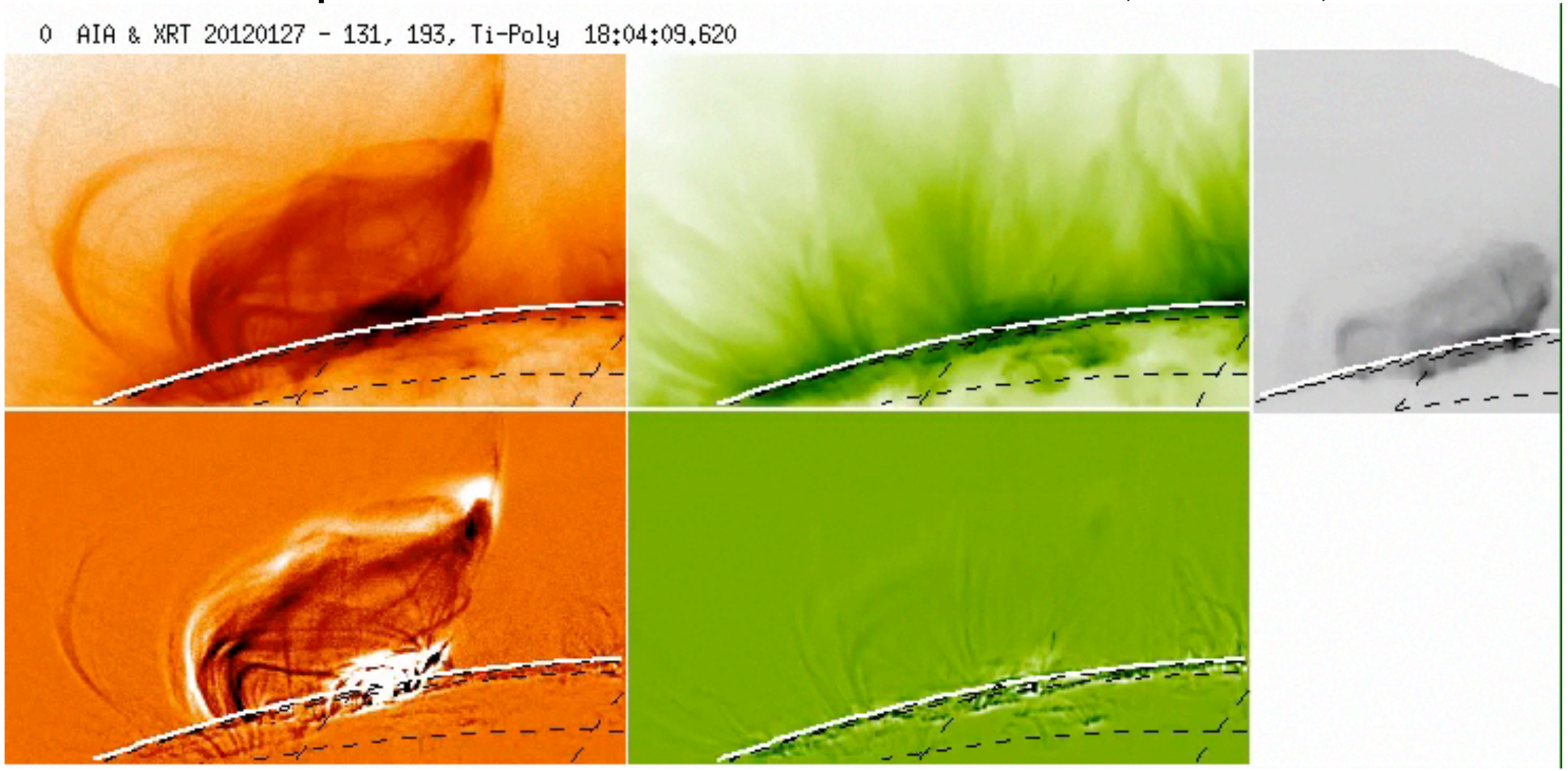
$$\beta = \frac{p}{(B^2/8\pi)} \approx 8$$

$$\nu_\mathrm{A} = \frac{B}{\sqrt{4\pi n_p m_p}} \approx 2 \times 10^7 \mathrm{cm\,s}^{-1}$$

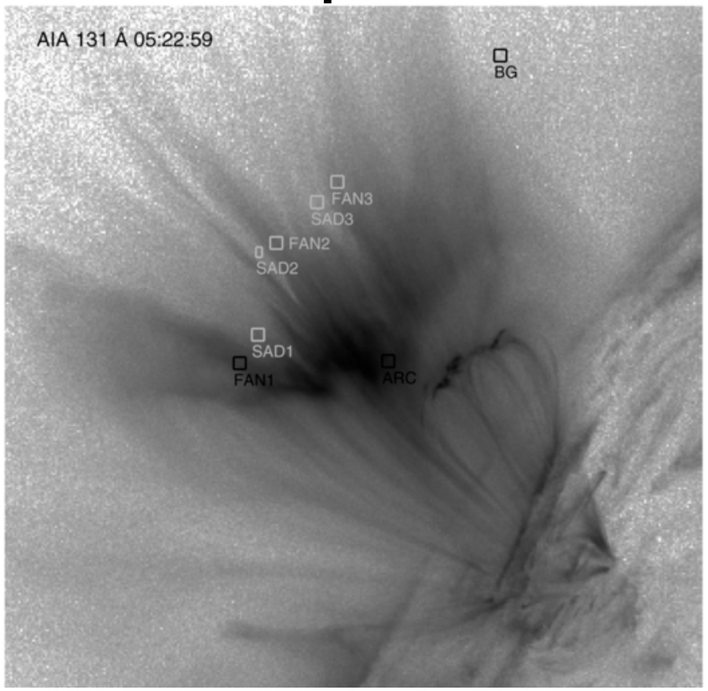
Coronal Estimates From McKenzie 2013

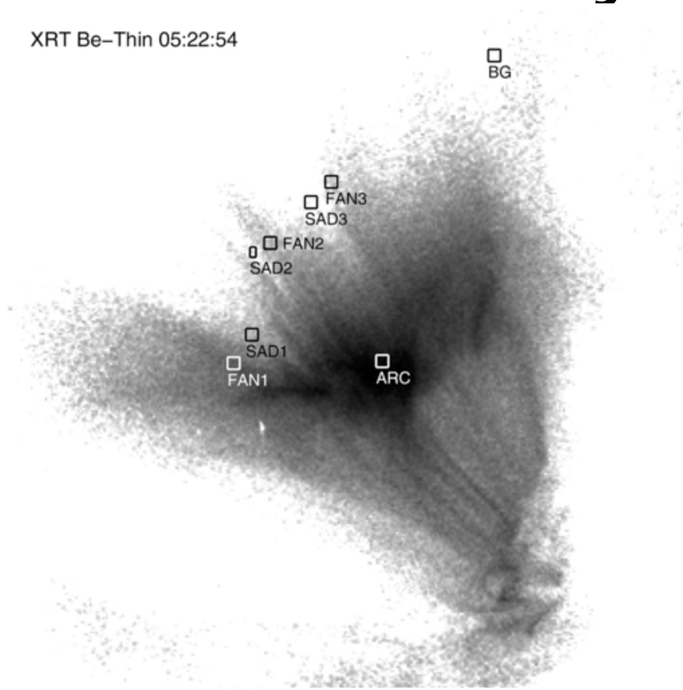
Magnetotail Measurements From THEMIS/later slides

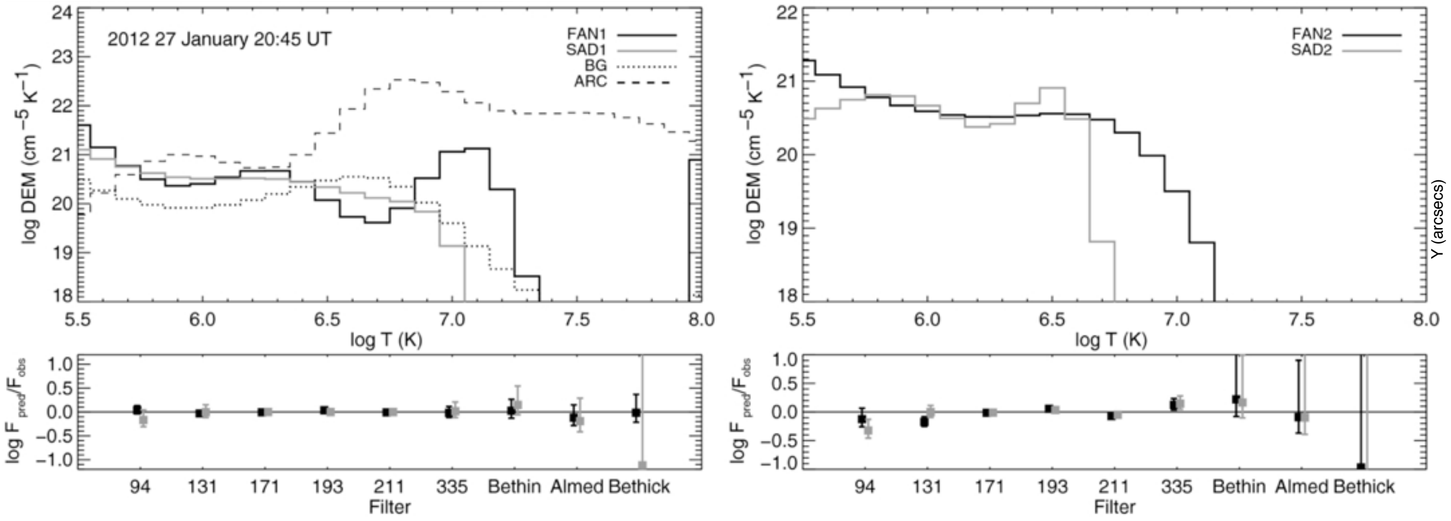
Supra Arcade Downflows (SADs)



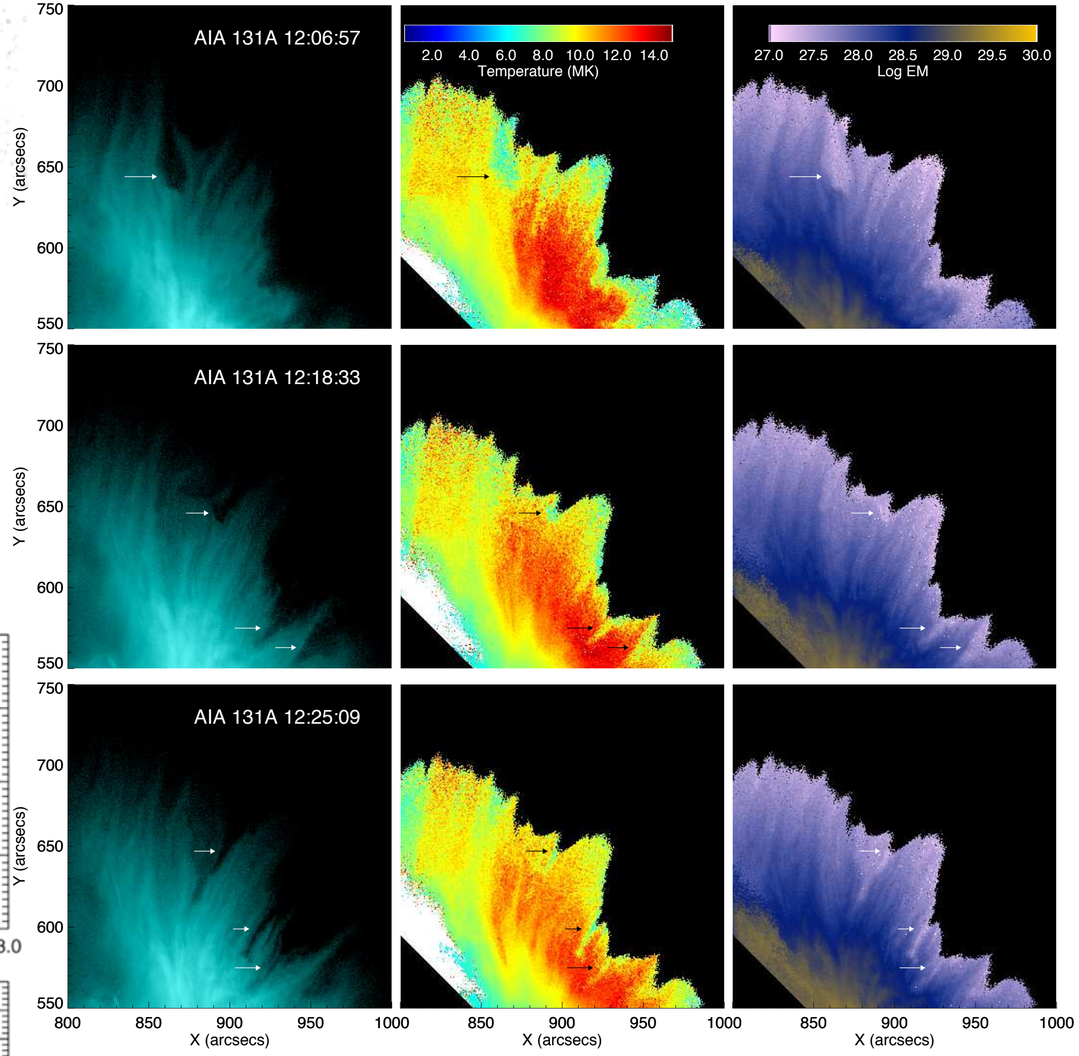
Temperature and Density Estimates of SADs





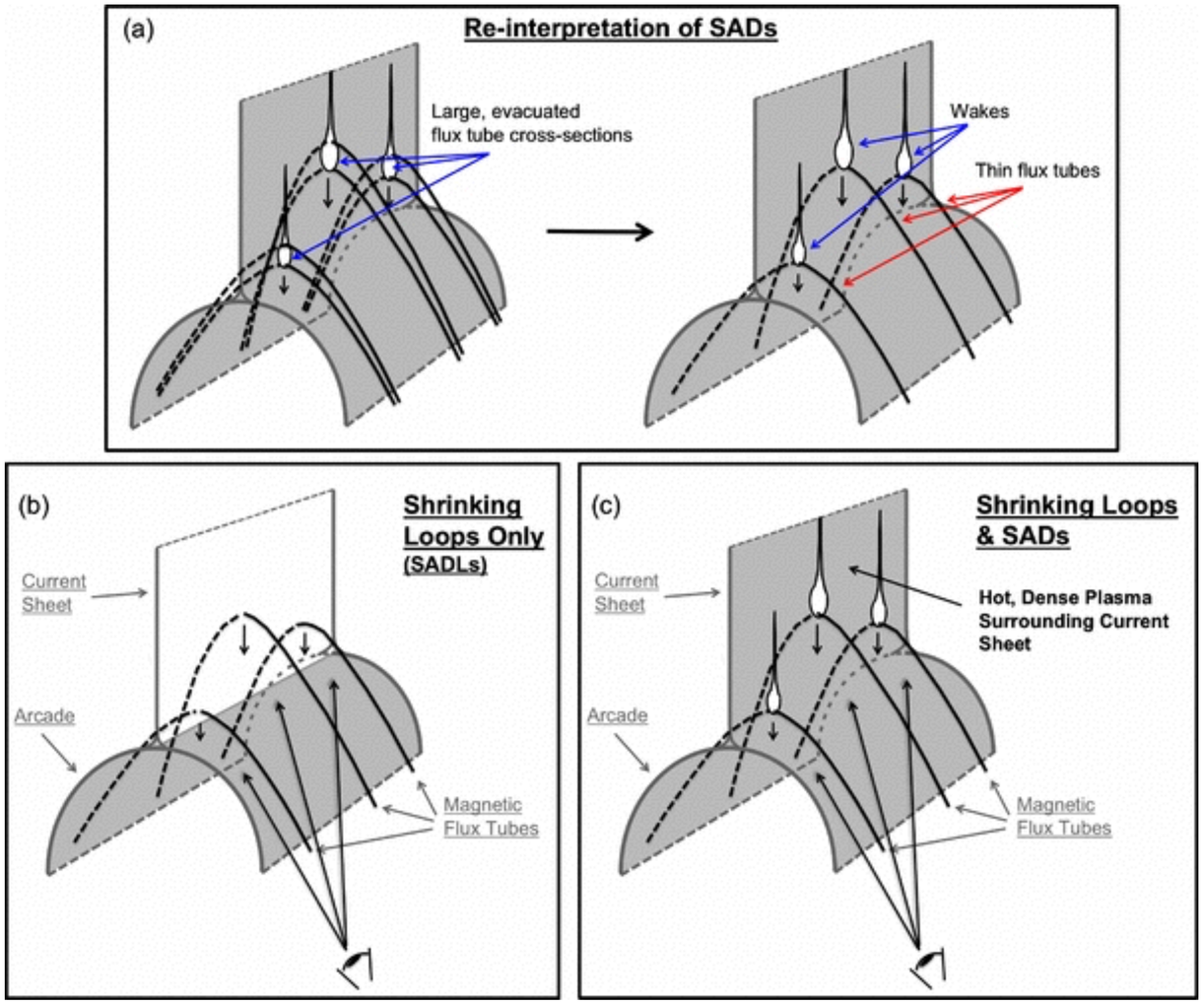


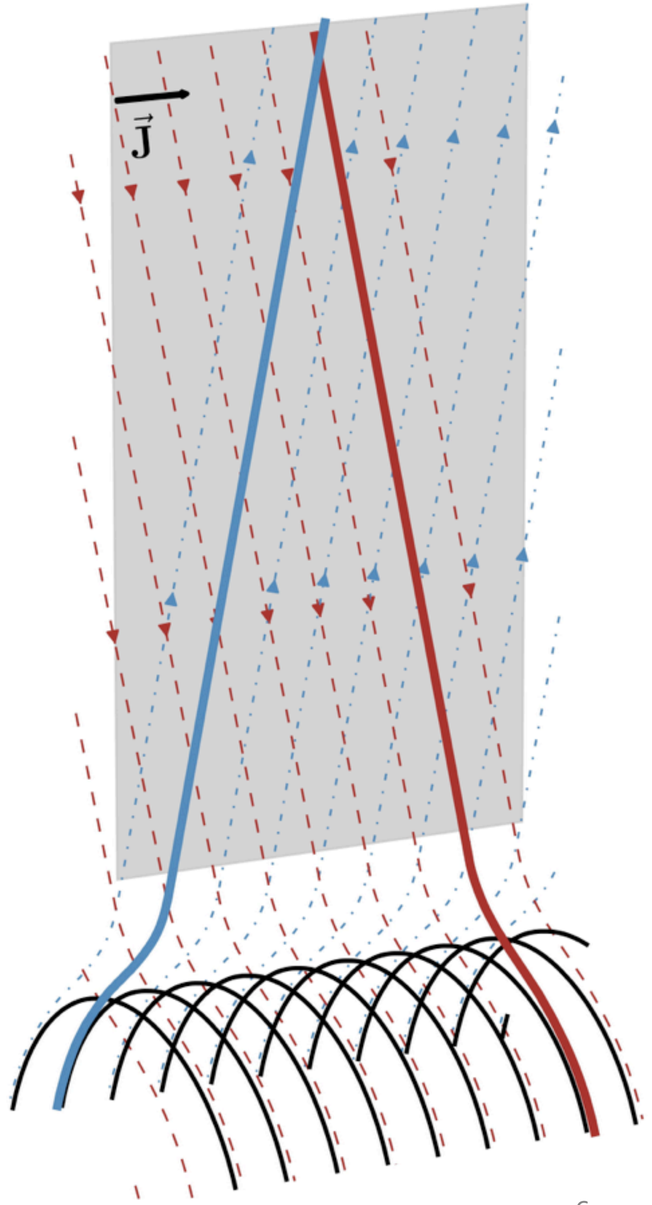
From Hanneman and Reeves 2014



From Reeves et al 2017

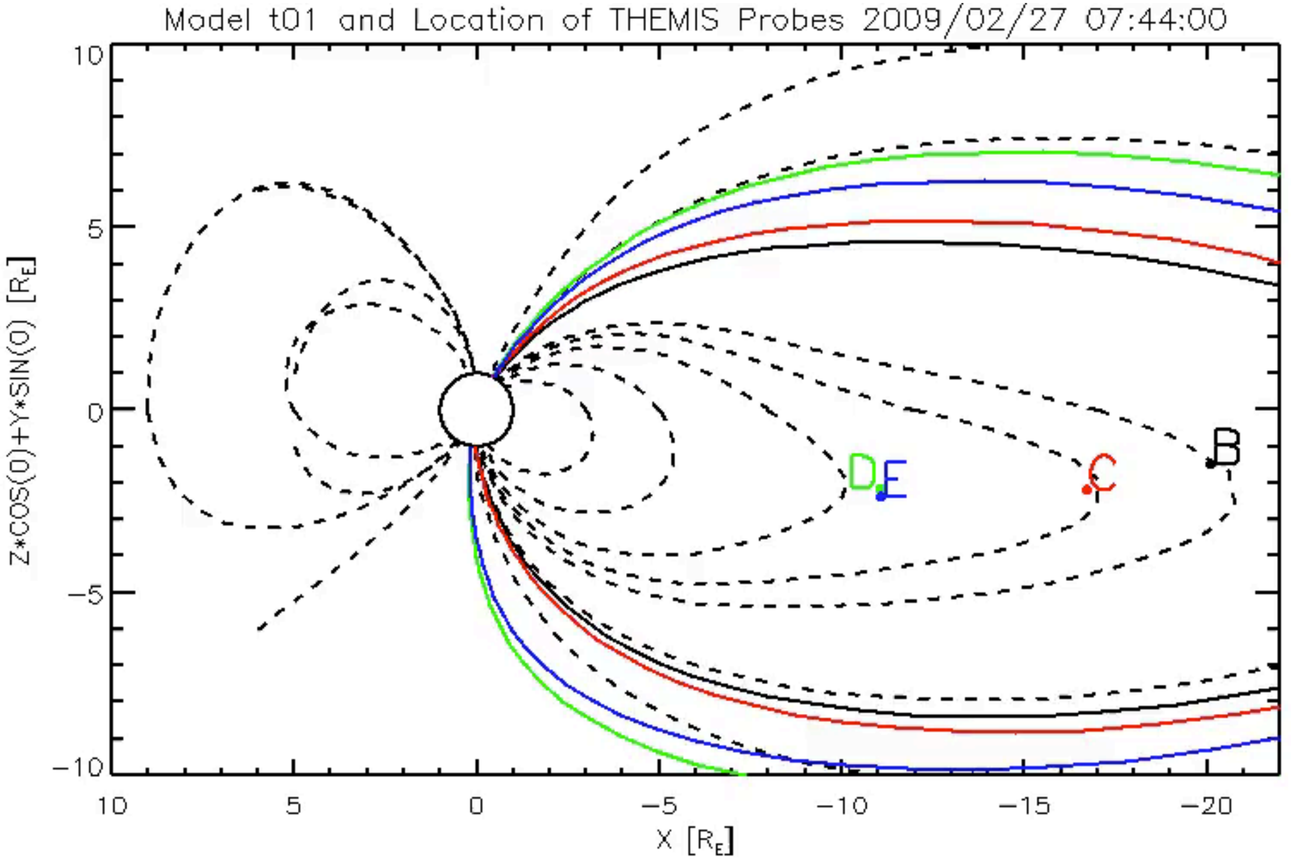
Supra Arcade Downflows

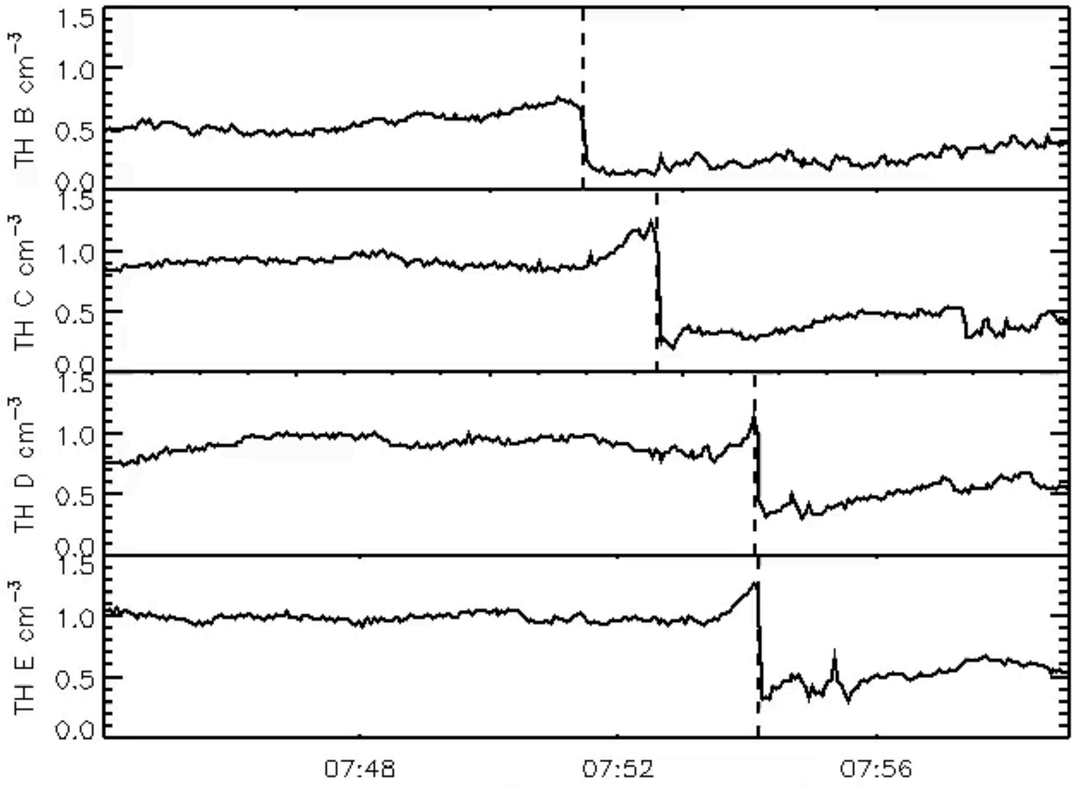


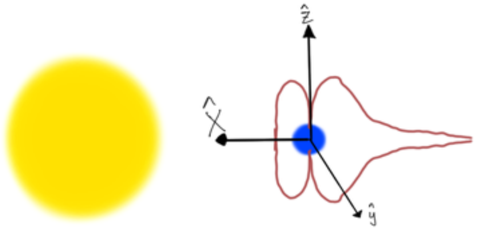


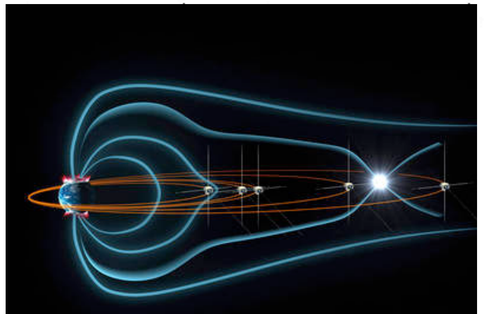
From Savage et al. 2012

Time History of Events and Macroscopic Interactions during Substorms (THEMIS)

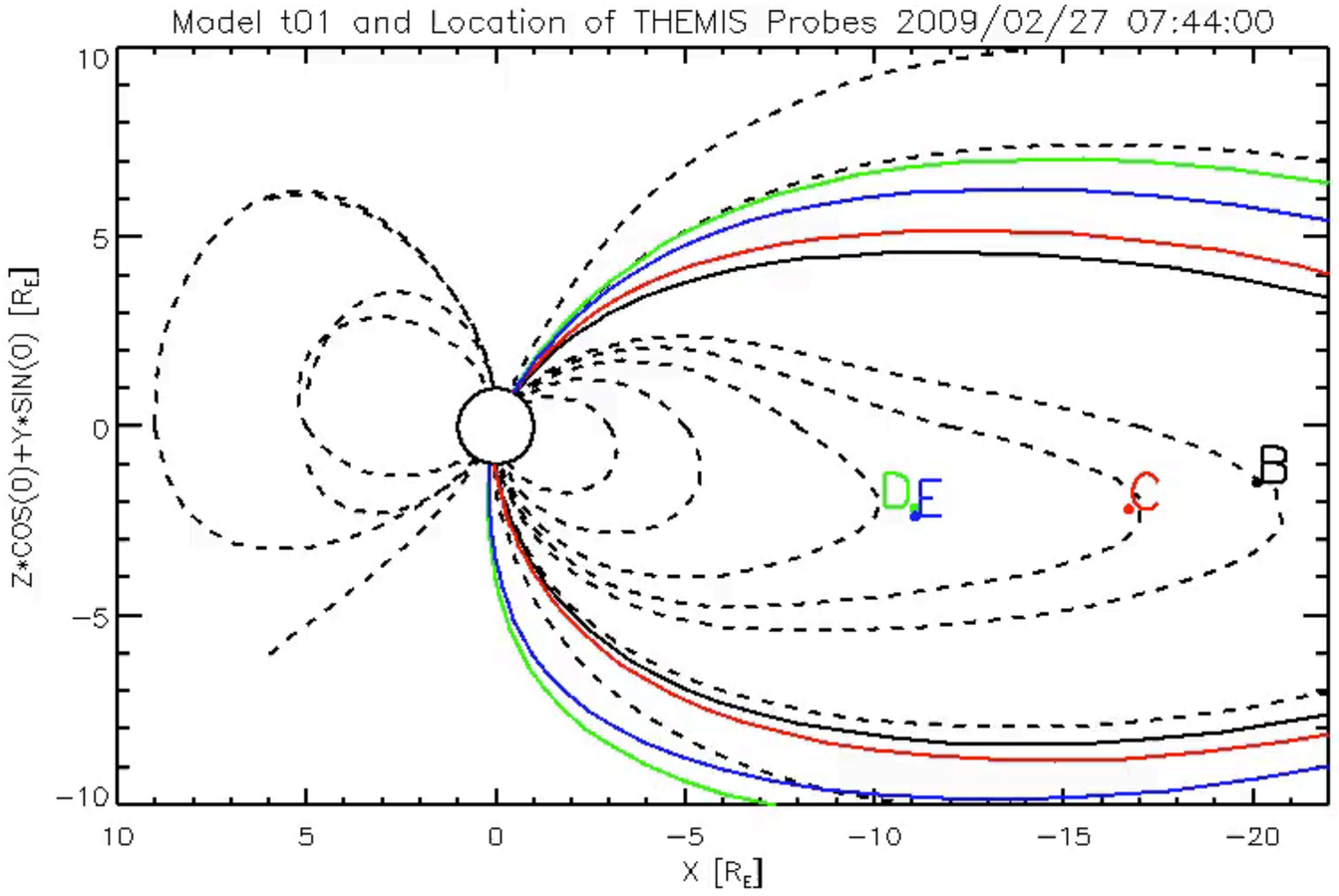


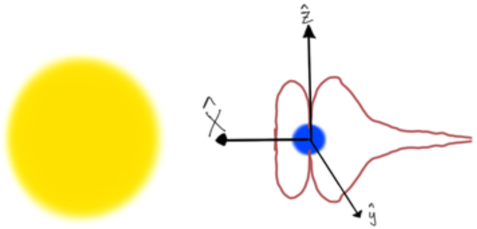


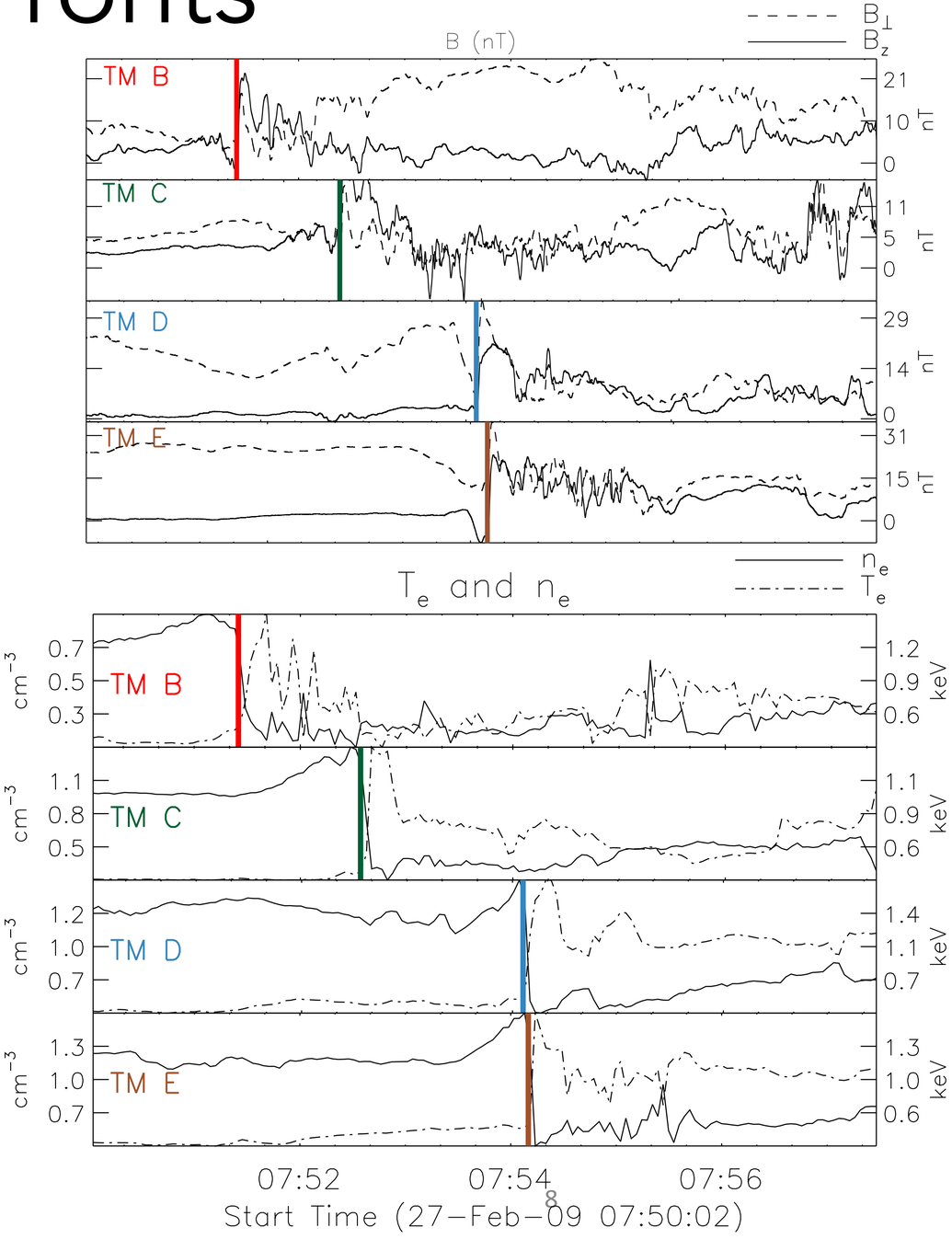




Dipolarization Fronts

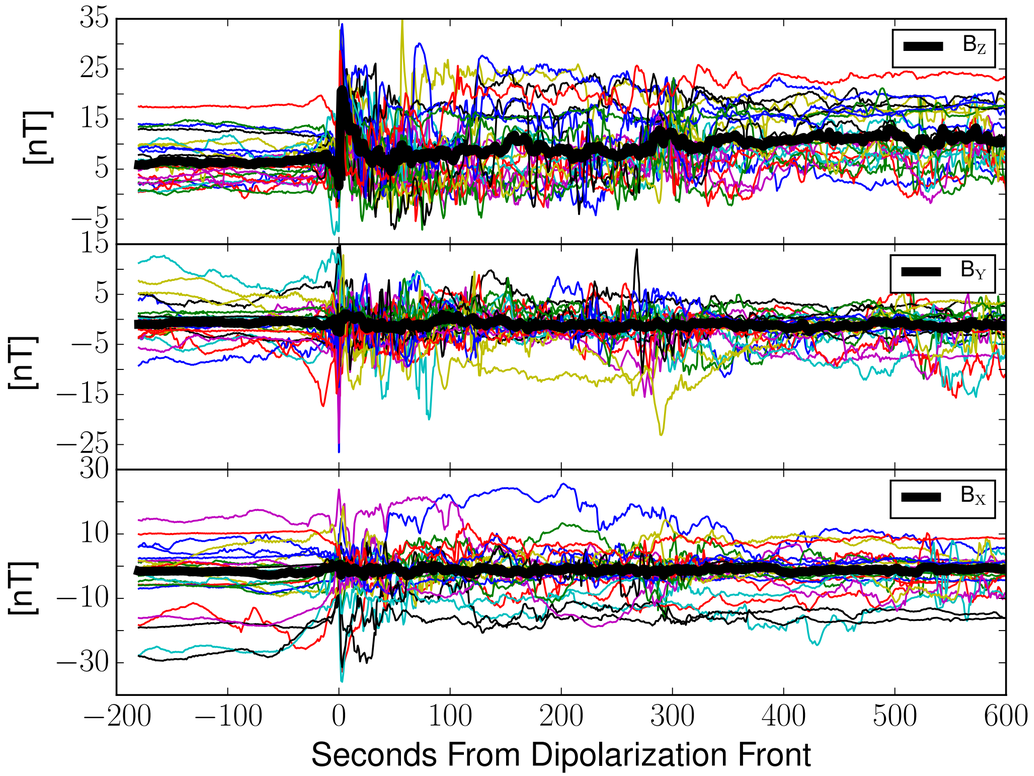




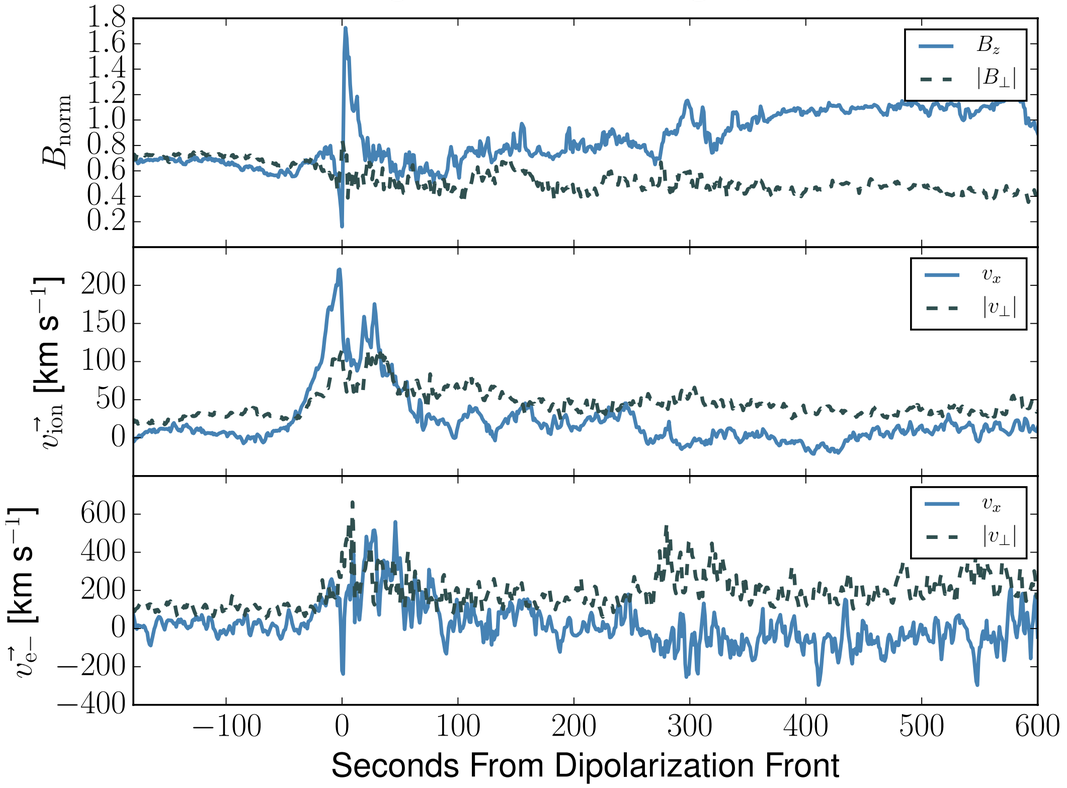


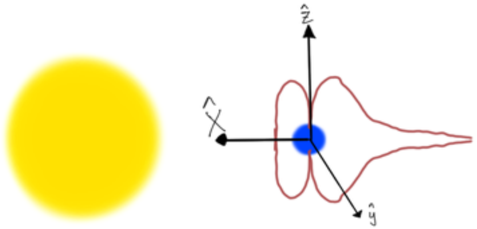
Generalizing Dipolarization Fronts

Magnetic Field Strength from all events and spacecraft



Normalized Magnetic Field Strength, and velocities

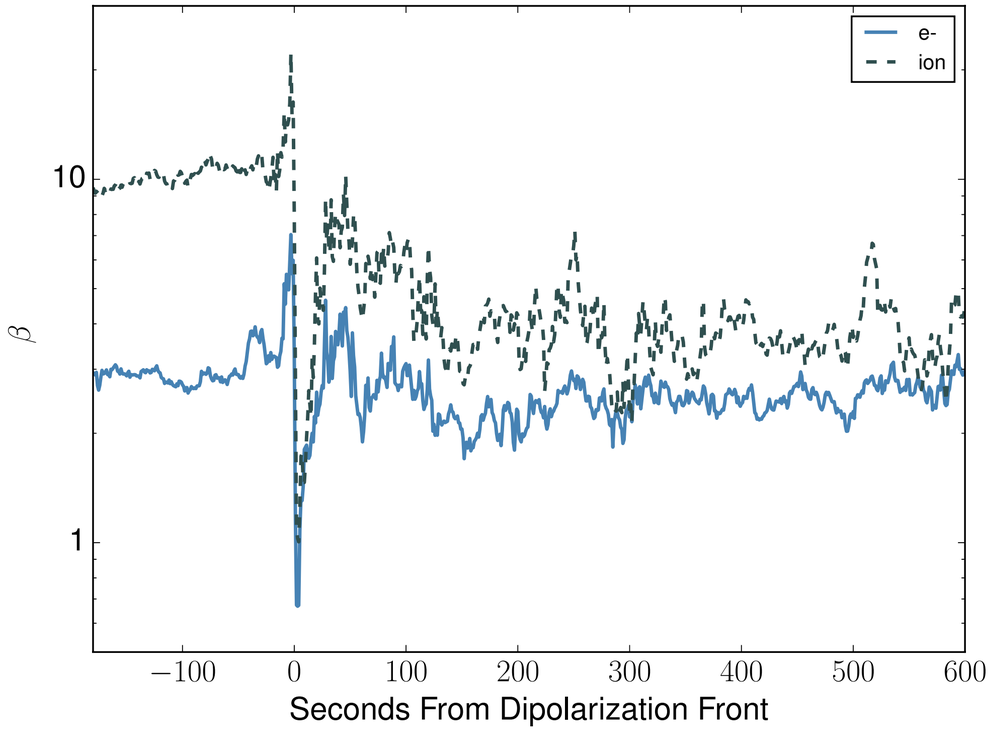




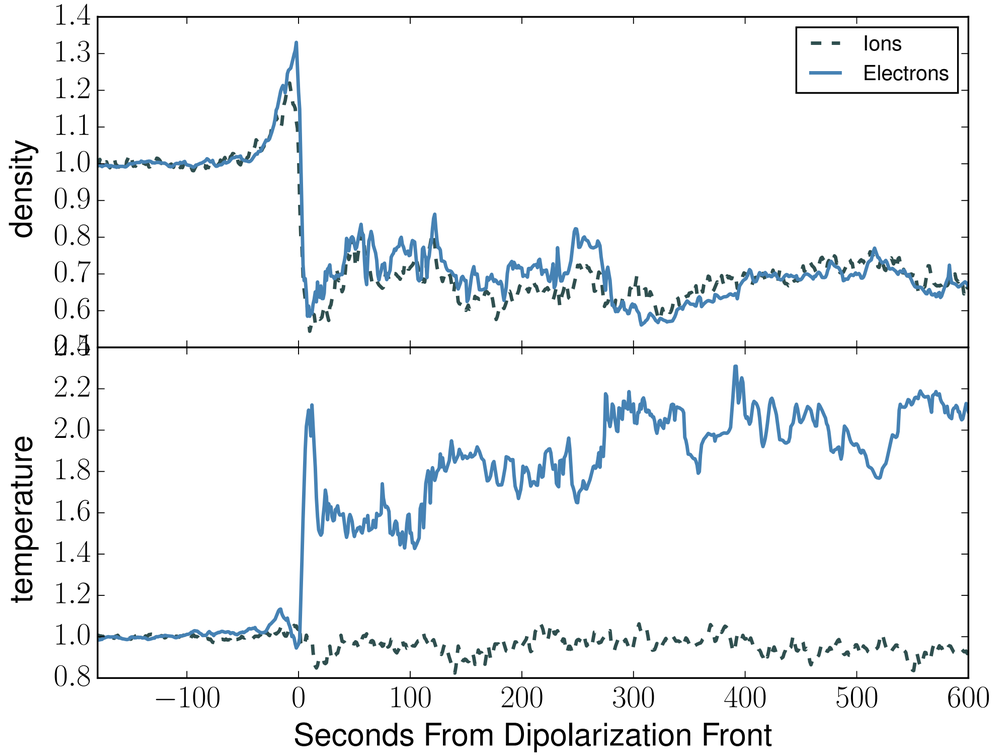
Dataset of 6 events each observed by up to 5 THEMIS spacecraft
(as listed in Runov et al. 2011)

Generalizing Dipolarization Fronts

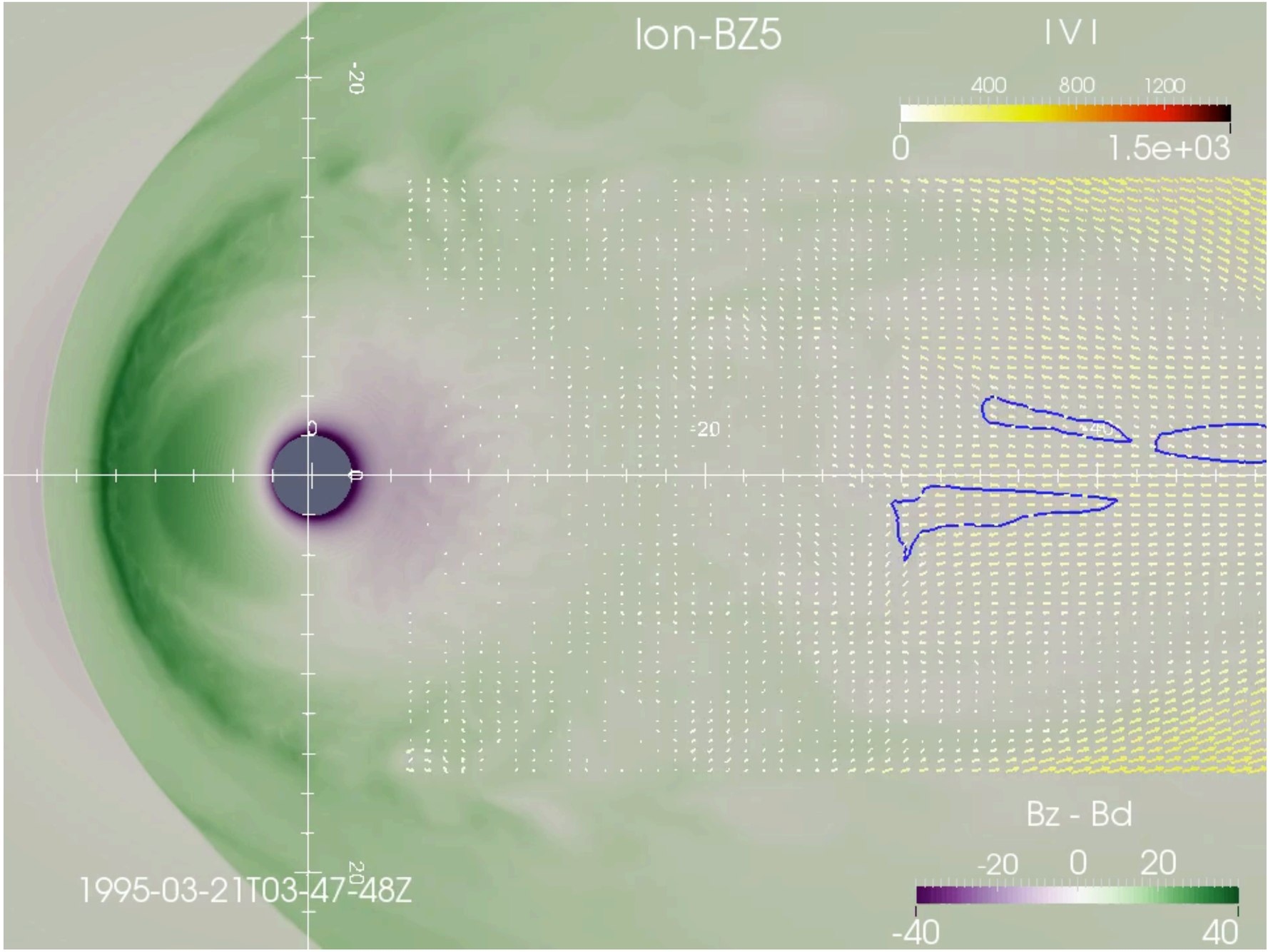
Normalized Plasma Beta



Normalized Temperature and Density

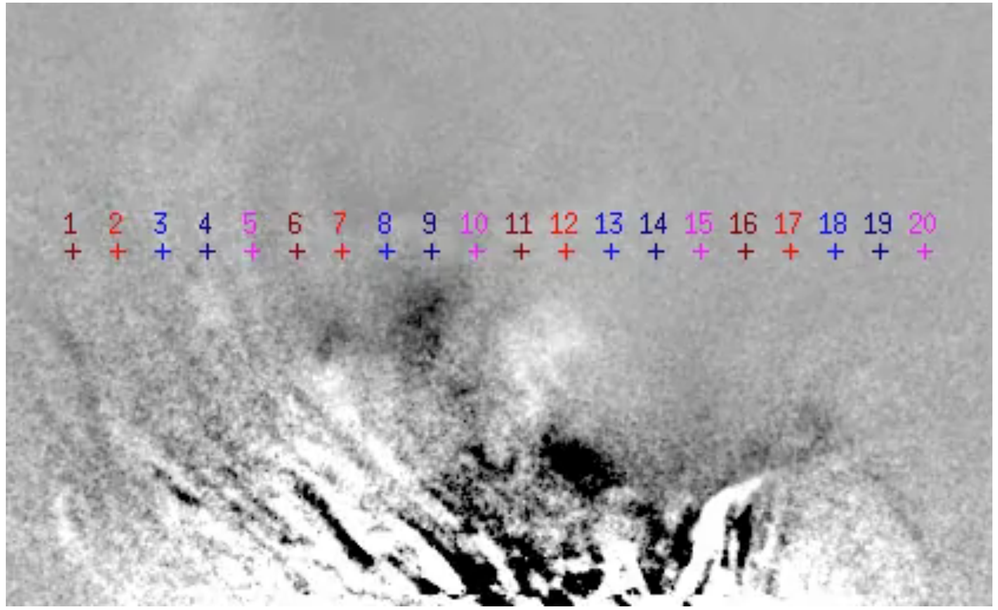


Dataset of 6 events each observed by up to 5 THEMIS spacecraft
(as listed in Runov et al. 2011)



. SIMULATION from Wiltberger, M., V. Merkin, J. G. Lyon, and S. Ohtani (2015), High-resolution global magnetohydrodynamic simulation of bursty bulk flows, *J. Geophys. Res. Space Physics*, *120*, 4555–4566, doi:10.1002/2015JA021080.

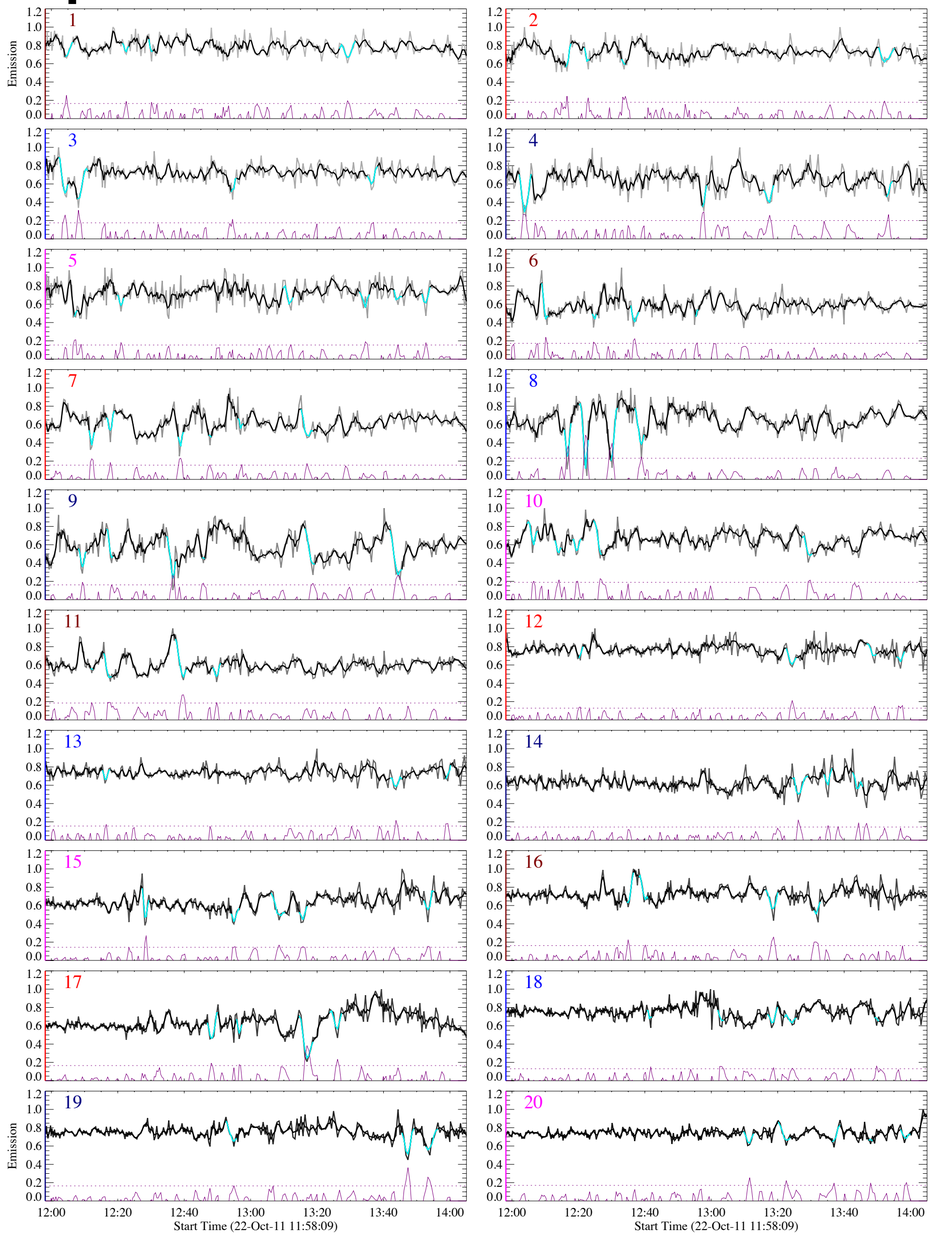
Observing SADs as Dipolarization Fronts



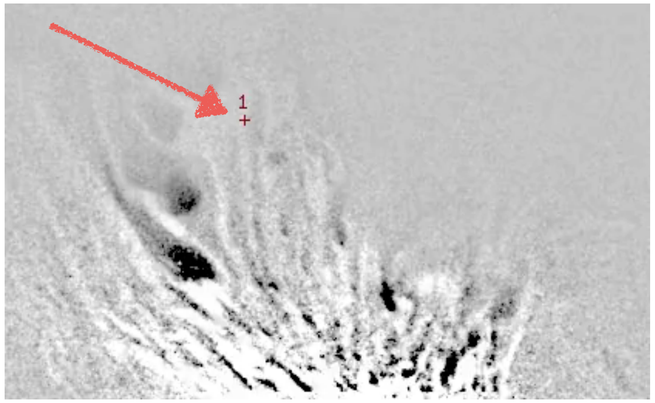
AR 11314 (GOES M1.3) between ~9:30 and 10:00 UT

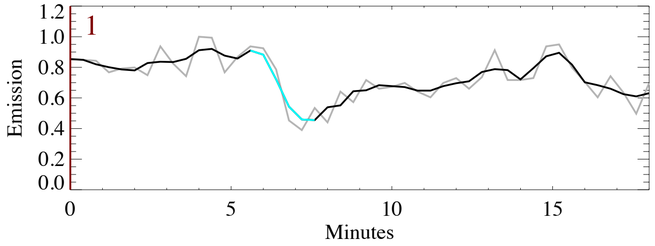
SOL2011-10-22

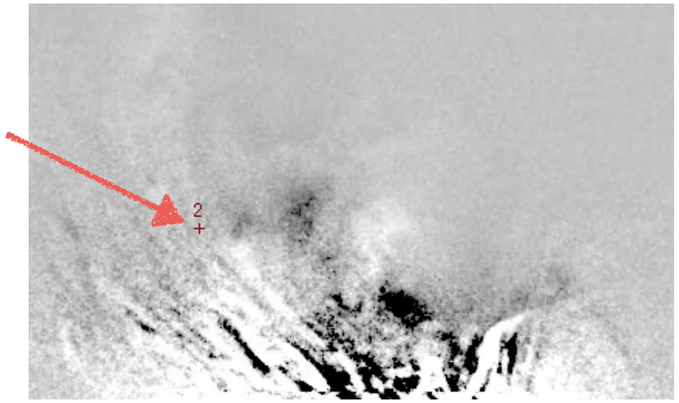
AIA 131 running difference.

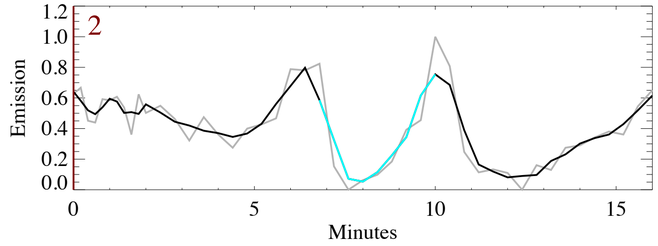


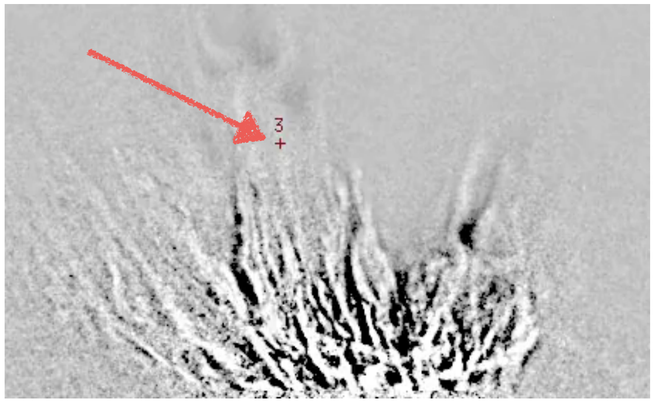
Observing SADs as Dipolarization Fronts

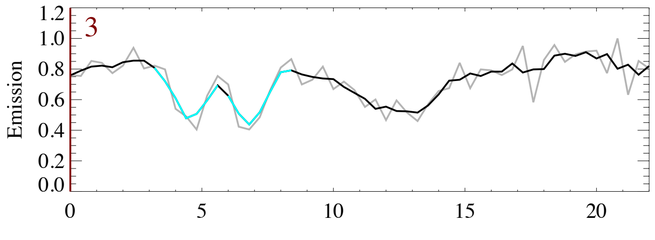


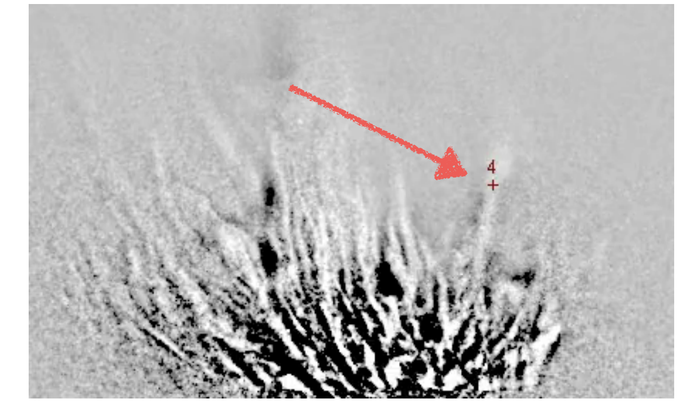


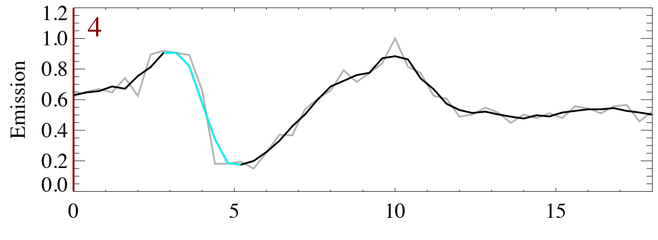












Summary

- Dipolarization fronts clearly show wakes behind collapsing/retracting loops in the magnetosphere during/ after substorms
- Dipolarization fronts should have coronal counterparts in solar flares
- SADs are low density sunward moving regions observed above solar flares
- Observations of SADs show similar features to Dipolarization Fronts
- Some SADs are the wakes behind collapsing loops, like dipolarization fronts.
- The velocity, density, temperature and magnetic field behaviors of observed Dipolarization Fronts provide useful checks for models of SADs
- Will continue to analyze SADs as DPFs to better understand these events.